

3. *Only long-run forward-looking economic cost may be included. The long-run period used must be a period long enough that all costs may be treated as variable and avoidable. The costs must not be the embedded cost of the facilities, functions, or elements. The study or model, however, must be based upon an examination of the current cost of purchasing facilities and equipment, such as switches and digital loop carriers (rather than list prices).*

By design, neither BCPM3.0 nor HM5.0 relies on embedded “facilities, functions, or elements” but rather take a scorched node approach to network design. As we discussed in Section I, however, the scorched node approach to modeling a hypothetical market participant is not likely to accurately reflect the costs of a dynamically efficient actual market participant—whether the participant is an incumbent or an entrant.

The models are not always consistent or definitive as to what constitutes forward-looking, least-cost practices. This may be due to the lack of an integrated analysis of the engineering parameters required to provide the defined set of services and the economic evaluation of the least-cost method of providing the services. This is a limitation of proxy models, which necessarily rely on general rules of thumb and publicly available data. Proxy models simply cannot account for all the factors specific to a decision and do not have access to all the information that are used to determine forward-looking, least-cost decisions by actual market participants.¹⁹

Both models purport to assign forward-looking costs to modeled elements. This criterion requires that input prices and other cost factors be based on costs

¹⁹ For instance, as noted above, the switching costs estimated by both models are not likely to be truly forward-looking. BCPM3.0 is more advanced in this respect. However, because of the need to use publicly available data, BCPM3.0 relies on existing host, remote and stand-alone designations, which likely vary from forward-looking, least-cost determinations of the mix of switch types actually performed by companies.

currently faced by incumbent LECs. Although it is not the focus of this phase of the FCC's evaluation, our analysis of the current versions of the models indicates that validation of input values is still a significant effort to be undertaken. In some cases, the assumptions that link current costs of facilities and equipment to the model parameters are clearly suspect. An example is the \$20,000 cost per transaction/second (TPS) for SCP hardware in HM 5.0. This figure is derived from a 1990 cost survey, which priced SCP hardware at \$30,000/TPS. The HM developers' judgment is that 1997 forward-looking cost is 2/3 of the 1990 figure, but comparable computer hardware is actually much cheaper in 1997.²⁰

Although this input has little impact on per-line investment, it is possible that there are other significantly misstated input prices with larger investment and cost consequences, particularly since many of the models' cost inputs are not directly comparable to one another. For example, BCPM3.0 and HM5.0 account for plant installation costs in different ways, making it difficult to compare or judge the reasonableness of these costs in the two models. For the most part, HM5.0 provides more extensive documentation of default cost parameters. However, by their own admission, developers of the BCPM have recently devoted most of their attention to model platform issues and have left inputs basically unchanged since version 1.1 of the BCPM.

²⁰ We have found a few more recent price points for SCP-type computer hardware that suggests the \$20,000/TPS figure is overstated by a factor of at least 3 or 4. The June 1994 issue of an on-line newsletter called IRIS Online reported a cost of \$5,434/TPS for a Silicon Graphics Challenge server. A Silicon Graphics press release from 1997 reported that one of their Origin 2000 systems (the successor to the Challenge line) had set a speed record by reaching 25,000 transactions per minute at a cost of \$8,340/TPS. A reasonable assumption is that less speedy systems would cost less than \$8,340/TPS.

HM5.0 expenses are based in part on ARMIS data, which the HM documentation describes as reflecting “embedded” costs. The HM logic converts these embedded expenses into forward-looking expenses by application of a forward-looking expense factor, which is arbitrarily set at 50 percent of embedded expenses. There is no foundation for this factor. The BCPM3.0 approach, in which both fixed per-line amounts and ratios to investment can be specified independently for several expense categories, is more flexible.

4. *The rate of return must be either the authorized federal rate of return on interstate services, currently 11.25 percent, or the state’s prescribed rate of return for intrastate services. We conclude that the current federal rate of return is a reasonable rate of return by which to determine forward looking costs.*

Both models allow any desired rate of return to be specified by the user. However, neither model’s default rate of return equals 11.25%. Both models continue to use the default rate of returns found in the previous versions of the models: 10.01% for HM5.0 and 11.39% for BCPM3.0. BCPM3.0 is supplied with a pre-set “FCC scenario” that implements the 11.25% rate of return.

5. *Economic lives and future net salvage percentages used in calculating depreciation expense should be within the FCC-authorized range. We agree with those commenters that argue that currently authorized lives should be used because those assets used to provide universal service in rural, insular, and high cost areas are unlikely to face serious competitive threat in the near term.*

Both models permit economic lives and future net salvage percentages to be independently specified by the user. The ability to independently specify economic lives and future net salvage percentages is new to the Hatfield Model since release 3.1. The HM5.0 default lives mostly fall within the FCC-authorized range. BCPM3.0

default lives are significantly shorter than the lower bound of the FCC-authorized range for several key accounts—in particular, aerial, underground, and buried cable. However, BCPM3.0's "FCC scenario" provides a set of economic lives and future net salvage percentages consistent with FCC-authorized ranges.

6. *The cost study or model must estimate the cost of providing service for all businesses and households within a geographic region. This includes the provision of multi-line business services, special access, private lines, and multiple residential lines.*

BCPM3.0 accounts for all loops. The residential line multiplier table provides the ratio of residential lines to households for each state. The use of this ratio accounts for both single and multiple line residences. Ratios greater than one imply that, overall, there are more telephone lines than households. There is also a corresponding business line multiplier table to account for single and multi-line business lines. Additionally, the model accounts for private lines by assuming they vary by grid, depending on the number of business switched access lines in each grid. The table accounts for DS-0 (voice grade), and switched and special DS-1s (1.544 MBps).

As noted above, BCPM controls its estimates to the state level. Therefore, the use of the residential and business line multipliers provides an accurate number of loops at the statewide level. However, at sub-state (company, wire-center, CBG, CB) levels, the estimated line counts can vary from actual line counts.

HM5.0 accounts for the number of switched access lines by controlling to the reported number of lines by company. The sources used for line counts in HM5.0

range from 1993 to 1997.²¹ It is unclear if the older line counts have been adjusted to account for growth in access lines since the reports were published. Furthermore, HM5.0 does not estimate the number of higher speed special service loops (DS-1 and up) in its default configuration.²²

While both BCPM3.0 and HM5.0 include special access line counts, neither model appears to properly account for them. For example, at the main distribution frame, a voice-grade special may be cross connected to another loop that terminates in the same serving area, or it may be multiplexed and added to a transport system heading out to another end-office or possibly an inter-exchange carrier. The former scenario describes a situation in which one special service loop needs to be treated as if it was two loops. The latter scenario should be treated as one loop and one special service transport circuit.

As a percentage of the total number of switched access lines, the number of special service loops is quite small. Therefore, the costs of collecting adequate data may outweigh any benefit from having better estimates of the number of access lines. Each of the model developers should, however, address how they are treating the special service line counts.

7. *A reasonable allocation of joint and common costs should be assigned to the cost of supported services. This allocation will ensure that the forward-looking*

²¹ The sources for line counts are found on page 20 of the Hatfield Model description. They are: ARMIS 43-08, (10/01/97); ARMIS 43-01, (10/01/97); NECA USF loops filing, 1996; RUS report, 1995; 1993 USF Data Request; and ARMIS-based line factors.

²² The number of DS-1's, as a percent of total lines, can be set by the user in HM5.0. However, this percent does not vary by the number of lines per grid, as it does in BCPM3.0. Given the number of higher speed lines is likely to be relatively greater in higher density categories with greater concentrations of businesses, this is a deficiency of HM5.0.

economic cost does not include an unreasonable share of the joint and common costs for non-supported services.

Both models include calculations that allocate joint and common costs to supported services. However, such allocations are inherently arbitrary and there is no economic basis on which to judge whether any allocation is "reasonable." Such costs may be specified in BCPM3.0 as per-line amounts or as percentages of investment. HM5.0 support and overhead allocations may now be allocated by lines or by direct expenses using user-adjustable factors. HM5.0's corporate (variable) overhead factor is 10.4%; the same as in HM 3.1.

8. *The cost study or model and all underlying data, formulae, computations, and software associated with the model should be available to all interested parties for review and comment. All underlying data should be verifiable, engineering assumptions reasonable, and outputs plausible.*

Both developers have supplied versions of the models to all interested parties. Not all of the underlying data is verifiable, however. Both models rely on a substantial amount of exogenous processing. The primary example of this is the customer location functions of both models. The input to HM5.0 is a database of records where each record represents the input data for one cluster. The input to BCPM3.0 is a database where each record represents the input data for one ultimate grid. In each model, the processing of the original data (geocoded addresses and Census Block data) have already been performed and the results rolled up into the model input files.

For BCPM3.0 the assignment of Census Block household detail to the grids could be made endogenous to the model. However, processing time would be

significantly increased. At the very least, the model uses Census Block level detail that can be externally validated by interested parties. This is not the case with HM5.0.

Users of HM5.0 have to assume that the addresses have been accurately geocoded. However, this assumption is tenuous, at best. When the BCPM developers tried to repeat the process used by the Hatfield Model's developers, they reported that they could accurately geocode only 56 percent of addresses.²³ The Hatfield Model developers dispute this, countering that the Metromail database contains over 90 percent of all residential addresses in the United States.²⁴ However, regardless of the percentage of addresses that have been geocoded, the accuracy of the addresses that have been geocoded remains an issue.

In addition, the introduction to HM5.0's documentation shows the high licensing costs associated with using Metromail as a source for geocoded addresses. As a result, we do not believe that HM5.0 satisfies the FCC's Criterion number 8. Without access to the raw household locations, HM5.0's assumptions are not verifiable. Access to household locations would enable one to test whether HM5.0's assumptions are accurate and whether BCPM3.0 customer location

²³ "Submission of BCPM3 Model by BellSouth Corporation, BellSouth Telecommunications, Inc. US WEST, Inc., and Sprint Local Telephone Companies," CC Dockets 96-45 and 97-160, December 11, 1997, pp. 6-8, and Attachment 4. The BCPM sponsors used satellite photograph analysis to plot the locations of housing units in several wire center serving areas. They also plotted the geocoded addresses from Metromail and GDT data. The charts produced by the BCPM sponsors clearly show that the Hatfield Model is only capable of accurately geocoding urban customer locations. By simply assuming that the addresses that cannot be geocoded are located along the perimeter of the Census Block, the Hatfield Model will be least accurate in high-cost rural areas--the areas that universal service funds are meant to support.

²⁴ Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, Secretary, Federal Communications Commission, December 23, 1997.

sources and algorithms produce similar results. This is a key issue that has obvious impacts on the network design of the models.

9. *The cost study or model should include the capability to examine and modify the critical assumptions and engineering principles. These assumptions and principles include, but are not limited to, the cost of capital, depreciation rates, fill factors, input costs, overhead adjustments, retail costs, structure sharing percentages, fiber-copper cross-over points, and terrain factors.*

Both BCPM3.0 and HM5.0 satisfy this criterion with respect to the assumptions and principles listed in the statement of the criterion. If anything, the developers of the models have provided an oversupply of user-adjustable parameters. This surfeit of user-adjustable parameters makes it possible to dramatically alter model results, but at the same time makes it virtually impossible to determine whether the models behave reasonably for all admissible parameterizations. The latest versions of BCPM and HM are, arguably, out of compliance with this criterion insofar as it is not possible to modify the assumptions and principles underlying the models' customer location algorithms.²⁵ In contrast, HCPM has partially fulfilled this criterion with the provision of the source code for its customer location module.²⁶

The abandonment of CBG-level customer location or serving area models has been carried out for the purpose of more realistic outside plant engineering, and thus can be said to play a critical role in determining model performance. Therefore, it is crucial that a complete examination of customer location algorithms and all data inputs be facilitated for all models.

²⁵ See discussion under Criterion 8 above.

²⁶ However, the data to run HCPM's customer location module do not appear to be available.

10. *The cost study or model must deaverage support calculations to the wire center serving area level at least, and, if feasible, to even smaller areas such as a Census Block Group, Census Block, or grid cell. We agree with the Joint Board's recommendation that support areas should be smaller than the carrier's service area in order to target efficiently universal service support.*

Both HM5.0 and BCPM3.0 will produce support calculation at the wire center level. Both models are also capable of producing results at the Census Block Group level. BCPM3.0 is capable of producing results at even finer levels of detail. HM5.0 will only produce results down to the Census Block Group level.

B. Summary - Evaluation of Proxy Models with respect to FCC's 10 Criteria

Our analysis has focused primarily on the BCPM3.0 and HM5.0 platforms. Model inputs will be examined in subsequent FCC proceedings and, thus, were not a major area of analysis in the current report. Because of the incomplete status of HCPM, it was not possible to evaluate the FCC Staff's model with respect to the FCC's 10 criteria. The incomplete nature of the HCPM leads to the obvious conclusion that the model does not meet the FCC's 10 criteria at this time.

Both BCPM3.0 and HM5.0 represent improvements over previous versions of the respective proxy models, benefiting from the extensive model evaluation and comment rounds that have taken place. However, at this point in time, neither model fully satisfies the FCC's 10 criteria. In terms of model platforms, BCPM3.0 appears to be more consistent with the FCC's criteria at this point in time.

A key area that remains unresolved is customer location. Both BCPM3.0 and HM5.0 have improved their customer location algorithms from previous versions of the models. However, because both BCPM3.0 and HM5.0 do a substantial amount

of exogenous processing and not all customer location data is readily verifiable, the accuracy of each model's customer location modules is difficult to assess at this time. In this respect the HCPM has an advantage because all of the source code for its customer location module are available for inspection. Complete access to customer location data and algorithms is necessary to determine the accuracy of HM5.0's geocoding and customer location assumptions, and BCPM3.0's customer location sources and algorithms.

Finally, it must be kept in mind that proxy models are not likely to accurately estimate the forward-looking cost levels of an efficient actual market participant. First, as we noted in Section I, the scorched node approach used by the proxy models produces the costs of a hypothetical market participant and is not likely to accurately reflect the forward-looking costs of an actual market participant. Second, given this qualification, proxy models are inherently limited in their ability to determine optimal solutions because of their general nature and their reliance on publicly available data. This is a limitation of all proxy models and not a shortfall of any particular model.

IV. Comparison of BCPM3.0 and HM5.0 Model Results

In this section, we compare results of the latest versions of BCPM3.0 and HM5.0 for the states that were both available for both models at the time of our analysis: Florida, Georgia, Maryland, Missouri, and Montana. First, we compare household and line counts for the two models.²⁷ Next, we compare annual cost and

²⁷ Limitations of HM5.0 required us to compile individual company results into statewide totals.

investment results for the models run with their default settings. Finally, we standardize key input values and compare annual cost and investment results.

A. Household and Line Counts

Table 1 compares household counts between BCPM3.0 and HM5.0. For all five states analyzed HM5.0 has greater household counts, ranging from 3 percent greater in Georgia and Montana, to 15 percent greater in Florida. BCPM3.0 still uses 1995 Census estimate of household counts, while HM5.0 uses estimates compiled from the Metromail database and 1996 Claritas CBG-level estimates of households with telephones.²⁸

Table 1
Household Counts – BCPM3.0 and HM5.0

	Florida	Georgia	Maryland	Missouri	Montana	Avg	Total
BCPM3.0	5,616,786	2,605,411	1,838,791	2,025,368	326,093	2,482,490	12,412,449
HM5.0	6,461,662	2,693,474	1,931,304	2,192,469	335,268	2,722,836	13,614,178
HM5.0/ BCPM3.0	15%	3%	5%	8%	3%	10%	10%

Table 2 compares total lines per household. In general, the overall line count for each state should be accurate for BCPM3.0, since it controls to statewide totals. On the other hand, HM5.0 controls to company totals, with a variety of sources ranging from 1993 to 1997 used to obtain company line counts. BCPM3.0 has greater total lines per household counts for Florida and Maryland, while HM5.0 total lines per household are greater for Georgia, Missouri, and Montana.

²⁸ See BCPM3.0 Documentation, p. 24, and HM5.0 Documentation, pp. 21-22.

Table 2
Total Lines Per Household – BCPM3.0 and HM5.0

	Florida	Georgia	Maryland	Missouri	Montana	Avg
BCPM3.0	1.75	1.69	1.85	1.55	1.42	1.71
HM5.0	1.62	1.80	1.83	1.71	1.57	1.70
HM5.0/BCPM3.0	-7%	7%	-1%	10%	10%	-1%

Each model presents line counts for a variety of categories: residential, single-line business, multi-line business, public lines and non-switched lines. In Table 3, we compare BCPM3.0 and HM5.0 residential lines per household. For all states, except Montana, HM5.0 has lower residential lines per household.

Table 3
Residential Lines Per Household – BCPM3.0 and HM5.0

	Florida	Georgia	Maryland	Missouri	Montana	Avg
BCPM3.0	1.21	1.11	1.15	1.09	1.06	1.16
HM5.0	1.08	1.10	1.12	1.02	1.08	1.08
HM5.0/BCPM3.0	-11%	-1%	-3%	-6%	2%	-7%

B. Comparison of Default Model Results

Table 4 compares the average monthly cost per line for the five states and also presents a weighted average (weighted by the states' number of lines) monthly cost per line across the five states. As with previous versions of the models, HM5.0 monthly costs per line are significantly lower than BCPM3.0's monthly costs. On average, HM5.0's monthly costs per line are 43 percent lower. Given the current focus on platform development, input values for both models have remained largely unchanged from previous versions of the models. Therefore, the wide gap between

model results is consistent with differences in the results for previous versions of the models.

Table 4
Average Monthly Cost Per Line – BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$30.78	\$38.42	\$28.49	\$46.17	\$111.82	\$36.04
HM5.0	\$16.26	\$22.22	\$16.35	\$27.78	\$68.87	\$20.58
HM5.0/BCPM3.0	-47%	-42%	-43%	-40%	-38%	-43%

Monthly (and annual) costs are comprised of two basic components: capital costs, consisting of a return on investment, depreciation and taxes; and expenses, consisting of operating expenses and an allocation of joint and common costs.

Table 5 compares BCPM3.0 and HM5.0 monthly capital costs per line and Table 6 compares monthly expenses per line between the two models

Table 5
Average Monthly Capital Costs Per Line – BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$19.44	\$27.08	\$17.15	\$34.83	\$100.48	\$24.70
HM5.0	\$9.33	\$13.75	\$8.78	\$19.22	\$49.93	\$12.70
HM5.0/BCPM3.0	-52%	-49%	-49%	-45%	-50%	-49%

Table 6
Average Monthly Operating Expenses Per Line – BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$11.34	\$11.34	\$11.34	\$11.34	\$11.34	\$11.34
HM5.0	\$6.93	\$8.48	\$7.57	\$8.56	\$18.94	\$7.89
HM5.0/BCPM3.0	-39%	-25%	-33%	-24%	67%	-30%

From Tables 5 and 6, it can be seen that HM5.0's monthly capital costs are an average of 49 percent lower than BCPM3.0's, and HM5.0's monthly expenses are an average of 30 percent lower. The notable exception is Montana, where HM5.0's expenses are 67 percent greater. Again, given the significant differences in the default input values between the two models on items such as rate of return, depreciation rates and expense loadings, these results are not unexpected.

Because the monthly results are generated from a number of key input values that have maintained their divergence from previous versions of the two models, a better comparison of the BCPM3.0 and HM5.0 model platforms is to examine investment per line for the two models. Table 7 compares total investment per line for BCPM3.0 and HM5.0. On average, HM5.0 investment per line is 43 percent lower across the five states, ranging from 40 percent less in Maryland to 50 percent less in Montana.

Table 7
Total Investment Per Line – BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$1,248	\$1,730	\$1,099	\$2,238	\$6,573	\$1,587
HM5.0	\$685	\$984	\$659	\$1297	\$3,270	\$902
HM5.0/BCPM3.0	-45%	-43%	-40%	-42%	-50%	-43%

Tables 8, 9 and 10 decompose total investment per line into loop investment per line, switch investment per line, and other investment per line. Other investment consists of transport, signaling, operator systems, and public telephones.

From Table 8, it can be seen that HM5.0 loop investment per line is an average of 48 percent lower than BCPM3.0's loop investment per line. This ranges from 37 percent lower in Maryland to 65 percent less in Montana.

Table 8
Loop Investment Per Line - BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$922	\$1,348	\$767	\$1,709	\$5,684	\$1,206
HM5.0	\$515	\$713	\$480	\$778	\$2,015	\$628
HM5.0/BCPM3.0	-44%	-47%	-37%	-54%	-65%	-48%

Table 9 shows that switch investment per line is an average of 54 percent lower for HM5.0, ranging from 46 percent lower in Georgia to 67 percent lower in Missouri.

Table 9
Switch Investment Per Line - BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$236	\$266	\$250	\$377	\$463	\$270
HM5.0	\$115	\$143	\$121	\$126	\$202	\$125
HM5.0/BCPM3.0	-51%	-46%	-52%	-67%	-56%	-54%

Table 10
Other Investment Per Line - BCPM3.0 and HM5.0
Default Results

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$90	\$117	\$81	\$153	\$426	\$111
HM5.0	\$56	\$127	\$58	394	\$1,052	\$148
HM5.0/BCPM3.0	-38%	9%	-29%	158%	147%	34%

Table 10 shows that HM5.0's other investment per line is an average of 34 percent greater than BCPM3.0's. This ranges from 38 percent lower in Florida to 158

percent greater in Missouri. Montana is also significantly higher (147 percent) for HM5.0.²⁹

In summary, there are still significant differences between BCPM3.0 and HM5.0 monthly costs. These differences are due to differences in annual capital charge and expense factors, and to significant differences in network investment estimated by the models.³⁰ The difference in investment produced by the models indicates that the BCPM3.0 and HM5.0 platforms that produce the underlying telephone network are still very different. The difference in investments in the models is primarily the result of two factors: differences in input prices and differences in network engineering. HM5.0 results could be lower because of lower input prices or because it places less plant than BCPM.

C. Comparison of Model Results with Standardized Inputs

The comparison of BCPM3.0 and HM5.0 investment per line above is still influenced by input value assumptions, in particular structure sharing and input prices. In this section, we standardize the structure sharing assumptions between the models to produce a more uniform comparison of investment. We equalize structure sharing by assuming that the telephone company incurs 100 percent of structure costs.³¹ However, due to the complexity of how input prices enter into the

²⁹ We discovered that HM5.0 did not compute any transport costs for 4 companies in Georgia—Camden, Ellinjay, Hawkinsville, and Interstate—and 1 company in Florida—Vista-United Telecom.

³⁰ As we have noted above, BCPM has not changed its capital and operating expense inputs in this version of the model. HM5.0, however, has lowered the lifetimes of its assets, resulting in a higher annual capital charge factor when compared to previous versions of HM.

³¹ Because of a problem with the input macro, we were unable to change a number of the structure sharing percentages in BCPM to 100 percent. If we were able to change all structure sharing percentages, the BCPM investment numbers would be slightly higher. We also change density-related fill factors to 80 percent (for all density zones) in both models.

respective models, we do not attempt to standardize them. In addition, we standardize the major capital and operating expense factors that produce differences in monthly costs. In particular, we use the following input assumptions for both BCPM3.0 and HM5.0:

- the BCPM3.0 11.39 percent weighted cost of capital;
- FCC asset lifetimes from the BCPM3.0 "FCC scenario" with straight-line depreciation;
- Net salvage percentages from the BCPM3.0 "FCC scenario";
- and the BCPM3.0's \$11.34 per line expense loading.

Table 11 compares the monthly cost per line with these standardized assumptions across the five states. On average, HM5.0 is now 16 percent lower (compared with 43 percent lower in Table 4), ranging from 13 percent lower in Maryland to 23 percent lower in Montana.

Table 11
Average Monthly Cost Per Line – BCPM3.0 and HM5.0
Standardized Inputs

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$28.61	\$35.50	\$26.50	\$42.31	\$102.21	\$33.33
HM5.0	\$23.68	\$29.21	\$22.99	\$36.73	\$78.52	\$28.10
HM5.0/BCPM3.0	-17%	-18%	-13%	-13%	-23%	-16%

Given that monthly expenses have been equalized at \$11.34 per line for the two models, the remaining differences between BCPM3.0 and HM5.0 are due to differences in investment per line and the translation of that investment into monthly capital cost per line. Table 12 shows that monthly capital costs per line are an average of 24 percent lower for HM5.0 (compared with 49 percent lower in Table 5), ranging from 18 percent lower in Missouri to 29 percent lower in Florida.

Table 12
Average Monthly Capital Costs Per Line – BCPM3.0 and HM5.0
Standardized Inputs

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$17.27	\$24.16	\$15.16	\$30.97	\$90.87	\$21.99
HM5.0	\$12.34	\$17.87	\$11.65	\$25.39	\$67.18	\$16.76
HM5.0/BCPM3.0	-29%	-26%	-23%	-18%	-26%	-24%

Table 13 indicates that total investment per line is an average of 32 percent lower for HM5.0 when structure sharing is equalized between the two models (compared to an average of 43 percent lower in Table 7).

Table 13
Total Investment Per Line – BCPM3.0 and HM5.0
Standardized Inputs

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$1,264	\$1,753	\$1,113	\$2,254	\$6,581	\$1,604
HM5.0	\$821	\$1,151	\$793	\$1,534	\$4,446	\$1,084
HM5.0/BCPM3.0	-35%	-34%	-29%	-32%	-32%	-32%

Table 14 indicates that loop investment per line is still an average of 34 percent lower for HM5.0 (compared to 48 percent lower in Table 8).

Table 14
Loop Investment Per Line – BCPM3.0 and HM5.0
Standardized Inputs

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$937	\$1,363	\$780	\$1,724	\$5,691	\$1,220
HM5.0	\$651	\$881	\$614	\$1,015	\$2,751	\$800
HM5.0/BCPM3.0	-31%	-35%	-21%	-41%	-52%	-34%

Therefore, while standardizing the structure sharing assumption does bring the models somewhat closer together, there is still a significant difference in loop

investment between the two models. This is due to differences in both input prices, which we have not been able to standardize, and basic loop engineering. Difference in customer location assumptions and algorithms are also a likely contributing factor, emphasizing the need for a complete evaluation and validation of customer location data and algorithms. In sum, there has not been much, if any, convergence between the models on this fundamental issue.

Table 15
Switch Investment Per Line – BCPM3.0 and HM5.0
Standardized Inputs

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$236	\$272	\$251	\$377	\$463	\$272
HM5.0	\$115	\$143	\$121	\$126	\$202	\$125
HM5.0/BCPM3.0	-51%	-47%	-52%	-67%	-56%	-54%

Table 15 shows that switching investment remains virtually unchanged from the default runs for the models found in Table 9. Minor differences occur in a few instances because changes in fill factors have altered line counts and switch sizes.

Table 16 shows that other investment remains essentially unchanged from Table 10, except for HM5.0 in Montana.

Table 16
Other Investment Per Line – BCPM3.0 and HM5.0
Standardized Inputs

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$91	\$118	\$82	\$153	\$427	\$112
HM5.0	\$56	\$127	\$58	\$394	\$1,493	\$158
HM5.0/BCPM3.0	-39%	7%	-30%	157%	250%	42%

D. Economies of Scope

As we have noted, in its default mode, HM5.0 does not provision high-speed circuits (greater than DS-0), while BCPM3.0 does. This led us to conclude that HM5.0 does not comport with the FCC's 10 criteria in that HM5.0 does not provide the range of supported and advanced services called for in the criteria. This also has implications for network costs for the two models. The ability to offer high-speed services should convey economies of scope and lower costs per line. Therefore, another aspect of the models that we need to standardize is the presence of high-speed special circuits. To control for this, we eliminated the high-speed circuits from BCPM3.0 to make the services offered by its network more comparable to those offered by HM5.0's network.

As we demonstrate, the presence of high-speed circuits in BCPM3.0 does produce economies of scope. Therefore, eliminating high-speed circuits from BCPM3.0 results in an even greater difference in costs per line between BCPM3.0 and HM5.0.

Table 17
Average Monthly Cost Per Line - BCPM3.0 and HM5.0
Standardized Inputs, No High-Speed Circuits

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
BCPM3.0	\$29.77	\$37.37	\$27.45	\$44.99	\$112.52	\$35.03
HM5.0	\$23.68	\$29.21	\$22.99	\$36.73	\$78.52	\$28.10
HM5.0/BCPM3.0	-20%	-22%	-16%	-18%	-30%	-20%

Table 17 compares monthly costs for BCPM3.0 and HM5.0 with the standardized inputs from the previous section and with high-speed circuits eliminated from BCPM3.0. Compared to the average 16 percent lower costs for

HM5.0 from Table 11, HM5.0 costs are now 20 percent lower. Therefore, the elimination of high-speed circuits from BCPM3.0 eliminates a source of economies of scope, exacerbating the difference between BCPM3.0 and HM5.0.

The increased difference between BCPM3.0 and HM5.0 when high-speed circuits are eliminated is due to increases in loop investment per line and other investment per line in BCPM3.0. Table 18 shows that BCPM3.0 total investment per line increases by an average of 7 percent when high-speed circuits are eliminated.

Table 18
Comparison of BCPM3.0 Total Investment Per Line
With and Without High-Speed Circuits

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
(1) Without High-Speed	\$1,348	\$1,883	\$1,181	\$2,440	\$7,283	\$1,723
(2) With High-Speed	\$1,264	\$1,753	\$1,113	\$2,254	\$6,581	\$1,604
(1)/(2)	7%	7%	6%	8%	11%	7%

This is due to an average 9 percent increase in loop investment per line (Table 19) and an average 5 percent increase in other investment per line (Table 20). There is no difference in switch investment per line when high-speed circuits are eliminated.

Table 19
Comparison of BCPM3.0 Loop Investment Per Line
With and Without High-Speed Circuits

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
(1) Without High-Speed	\$1,017	\$1,487	\$845	\$1,901	\$6,358	\$1,334
(2) With High-Speed	\$937	\$1,363	\$780	\$1,724	\$5,691	\$1,220
(1)/(2)	9%	9%	8%	10%	12%	9%

Table 20
Comparison of BCPM3.0 Other Investment Per Line
With and Without High-Speed Circuits

	Florida	Georgia	Maryland	Missouri	Montana	Wtd Avg
(1) Without High-Speed	\$95	\$125	\$86	\$163	\$462	\$118
(2) With High-Speed	\$91	\$118	\$82	\$153	\$427	\$112
(1)/(2)	5%	6%	4%	6%	8%	5%

IV. General comments on model operation

In addition to addressing the FCC's 10 criteria, we believe it is important to also report on our overall experience in running the current versions of the proxy models. We comment here on model installation and setup, user interface, and model execution and outputs.

A. Installation and Setup

Both BCPM3.0 and HM5.0 were more difficult to install than their predecessors. The BCPM3.0 installation requires over 600 megabytes of disk space, most of which is required for state-specific files. An option to install only selected states would be useful. Initially, neither BCPM3.0 nor HM5.0 would run due to software conflicts. Performing "clean" installations of the Microsoft Office 97 software, then re-installing the models solved the problems. Both models appear to be overly sensitive to the presence of other Visual Basic software. The HCPM installation procedure involved downloading or copying compressed files containing the model and data for individual states. It is easy to selectively install states in HCPM. However, none of the input files to the CENBLOCK module were provided

in the HCPM2.0 release, so it was not possible to run the customer location program.

B. User Interface

The HM5.0 user interface is essentially the same as HM3.0. HM's system of dialog boxes make it relatively easy to change parameter values for individual scenarios. However, applying a large number of parameter changes to multiple states through the user interface is tedious. Editing the Microsoft Access database that contains the HM5.0 scenario parameter values is relatively straightforward.

BCPM3.0 employs a significantly revised user interface relative to BCPM1.1. We encountered major problems with the macros that update BCPM user parameter values. BCPM3.0 uses a spreadsheet as the front-end to the process whereby text files with scenario-specific inputs are changed. An error in the macro that updates the text files prevented us from saving parameter changes through the user interface. Editing the text files, which are in comma-separated format, is difficult because they use vertical bars in addition to commas to delimit some input values. While investigating this problem, we also discovered that certain structure investment inputs cannot be changed through the user interface. Overall, the inputs section of the BCPM user interface appears to have been inadequately tested and debugged.

HCPM has no user interface. The text files containing user-adjustable inputs must be manipulated directly to alter parameter values. The model is run from the command line. Analyzing and using HCPM requires a great degree of programming

sophistication. This limits the ability to review the model and, thus, appears to be contrary to the FCC's position that proxy models must be presented in a manner that facilitates public evaluation.

C. Model execution and outputs

BCPM3.0 processes data at the state level. It is easy to run multiple states consecutively via the user interface. HM5.0 processing is at the company level. HM5.0 provides multiple company scenarios which process companies in batches. Model run times are longer than in previous versions, largely due to the more detailed customer location data provided with the models. Neither model tolerates interruption by other Windows system events, such as the Windows screen saver. In such cases, BCPM3.0 tends to halt outright; and HM5.0 output may be corrupted under such circumstances. BCPM3.0 report generation requires an additional, relatively time-consuming, processing step.

Once processed, BCPM3.0 offers significantly more flexible reporting capabilities than HM5.0. For instance, the "summary" and "detail" reports can be produced for companies, groups of companies, or states using the user interface. HM5.0 has a limited capability to summarize its monthly cost and universal service support results, but to summarize other HM5.0 results (such as investment amounts) requires extensive spreadsheet programming.

V. Conclusion

Our analysis has focused primarily on the BCPM3.0 and HM5.0 platforms. Because of the incomplete status of HCPM, it was not possible to evaluate the FCC Staff's model with respect to the FCC's 10 criteria. Currently, HCPM only models loop investment and does not model other network elements. In addition, HCPM does not currently have a capital cost or expense module, meaning that HCPM investments cannot be translated into monthly costs. The incomplete nature of the HCPM leads to the obvious conclusion that the model does not meet the FCC's 10 criteria at this time.

At this point in time, neither BCPM3.0 nor HM5.0 fully satisfies the FCC's 10 criteria. In terms of model platforms, BCPM3.0 appears to be more consistent with the FCC's criteria at this point in time.

A key area that remains unresolved is customer location. Both BCPM3.0 and HM5.0 have improved their customer location algorithms from previous versions of the models. However, because both BCPM3.0 and HM5.0 do a substantial amount of exogenous processing and not all customer location data is readily verifiable, the accuracy of each model's customer location modules is difficult to assess at this time. In this respect the HCPM has an advantage because all of the source code for its customer location module is available for inspection. Complete access to customer location data and algorithms is necessary to determine the accuracy of HM5.0's geocoding and customer location assumptions, and BCPM3.0's customer location sources and algorithms. However, it must be asked whether any proxy model, regardless of how sophisticated its algorithms and assumptions, will ever be